Influence of digital elevation model resolution on terrain based hydrologic parameters for a subalpine catchment, Front Range, Colorado

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Abstract: Understanding the reliability of digitally derived stream networks for mountainous areas is important to many water resource and land-use management applications. Digital elevation models (DEMs) have become an essential tool for mountain runoff analyses. Prior research has shown that accuracy of topographically derived stream networks vary both with the methods of calculation and the spatial resolution of the DEM used. As part of a larger study on stream networks for Loch Vale, a high-elevation catchment at Rocky Mountain National Park, we examine the influence of DEM resolution on spatially distributed topographic parameters important to stream network derivation. The analysis includes a comparison of local slope (tan β), specific contributing area (α_s), and topographic wetness index (TWI) values derived from 1, 10, and 30m DEMs using both eight (D8) and infinite directional (D∞) flow algorithms. Results show that decreasing DEM resolution leads to a substantial loss of detail in spatial patterns of tan β, α_s, and TWI. The D∞ flow partitioning algorithm also offers a visual improvement over the idealized network derived from D8. Statistically, using coarser DEMs and D∞ both shift the overall distributions of α_s and TWI towards higher values. When applying minimum contributing area or TWI thresholds for channel initiation at Loch Vale, coarser DEMs result in a larger percentage of catchment area defined as channelized. Hydrologically, routing more water to channelized flow versus sheet flow or overland flow versus subsurface flow will result in shorter lag-to-peak times and higher overall peak flows in modeled hydrographs.